ENAE 414 **EXAM II** **13 APR 2006**

PROBLEM #1 (20%) Consider a source of strength Λ located at $(x,y)=(-a,+b)$ where **a** and **b** are constants. At an arbitrary field point $P(r,\theta)$ write in polar coordinates **(1)** the velocity potential and **(2)** the radial and tangential components of velocity.

PROBLEM #2 (20%) Consider a doublet of strength $K=251\ m^3/sec$ combined with a uniform stream of velocity **40m/sec** to give non-lifting flow over a circular cylinder. Write **(1)** the equation of the streamline passing through the point $(r,\theta) = (2R, \pi/4)$ where **R** is the radius of the cylinder and **(2)** at the rearward point along this streamline where $r=10R$, what is the angle θ?

PROBLEM #3 (32%) Consider lifting flow over a circular cylinder in a free stream of velocity **40 m/sec**. If the lift coefficient is **3** calculate: **(1)** the maximum velocity on the cylinder in **m/s**, **(2)** the location of the stagnation points and **(3)** the location of the null points (those points where the pressure equals that of the free stream).

PROBLEM #4 (20%) A thin airfoil of chord **60cm** is represented for a given angle of attack by the vortex distribution along the x-axis $\gamma(x) = 10[1-(x/c)^2]$ from $x=0$ to $x=c$. Calculate **(1)** the circulation Γ and **(2)** the lift coefficient for this airfoil.

QUESTIONS (8%)

(1) What does the Fundamental Equation of Thin Airfoil Theory state?
(2) Does the Kutta condition result from a viscous or inviscid phenomenon?
(3) What is the physical interpretation of the strength of a point source?
(4) Is it mathematically possible to generate lift in the absence of vortices?

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